PATENT SPECIFICATION

DRAWINGS ATTACHED

956,724

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COMPLETE SPECIFICATION

Improvements in Spacing Means for Conductor Bars of Electrical Devices

We, GENERAL ELECTRIC COMPANY, a Corporation organized and existing under the laws of the State of New York, residing at 1 River Road, Schenectady 5, New York, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the manufacture of electrical devices which have conductor bars spaced apart, and the invention is concerned with means for maintaining adjacent conductors at the desired distance and for avoiding as far as possible relative movement between these conductors.

Although the invention is applicable to any electrical device having spaced conductor bars, it is particularly useful in its application to electric motors, generators and transformers and it will be described with particular reference to conductor bars of the stators of dynamoelectric machines.

The stator conductor bars and the end winding portions of electrodynamic machines are subjected during operation of the machines to various electrically induced mechanical forces which tend to deform them so that they come into contact one with the other, such forces being particularly aggravated during accidental short circuiting of the machines. In order to avoid such undesirable effects, it has been customary to space and restrict the movement of such conductor bars by the use of wooden blocks fitted between the bars and tied in place by means of glass fiber, cord or string. The installation of such wooden blocks requires that the conductor bars be inserted in the slots of the machine, the spaces to receive the blocks measured, blocks of approximately suitable size selected, and then fitted individually. The bars must then be removed from the slot so that the blocks can be tied in place, whereupon the conductor bars are replaced in the slot of the stator and the winding of the machine carried out to the next conductor bars. It is quite evident that this method is both tedious and economically unproductive. It will also be quite evident that the rigid wood blocks are incapable of taking up or closing any slack space which might inadvertently develop during the winding assembly procedure so that despite ordinary care, the machine as completed may have a loosely fitted end winding portion which, under the forces experienced in actual operation, would become aggravated and could lead to early failure of the machine as a whole.

It has been proposed to insert slugs of resinous or thermosetting material encased in extensible sleeve material between the conductor bars, the sleeve then being extended to transversely constrict the sleeve and cause the originally rectangularly shaped slug of resin to deform to a cylindrical shape, thus pressing against and spacing the conductor bars. The ends of the sleeve are then passed around one of the bars to hold the spacer in shape. While this method of fixing adjacent conductor bars has proved to be of advantage in certain respects, the sleeving used is relatively expensive and the deformation of the resin slug by pulling on the ends of the sleeve rather difficult to carry out.

It is the object of this invention to provide improved and simplified means for holding apart and limiting the relative movement between adjacent parallel conductor bars.

Therefore, the invention consists in a

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method of manufacturing electrical devices which have conductor bars spaced apart, which method includes the step of inserting glass-fibre filled conformable thermosetting resin blocks into spaces between adjacent conductor bars so as to maintain their spacing and restrict their mutual movement.

The glass-fibre filled thermosetting resin blocks, are preferably inserted between adjacent conductor bars in such a manner that the glass fibres are oriented in a direction parallel to the sides of the adjacent conductor bars that face the inserted blocks, and the blocks are then compressed at right angles to the fibre orientation by a force applied to the sides of the blocks which are parallel to the glass fibre orientation.

In order that the invention may be clearly understood it will now be described in more detail with reference to the accompanying drawing wherein

Figure 1 is a perspective view of parts of two adjacent conductor bars with a spacing block according to the invention inserted between them,

Figure 2 is an end view of the arrangement shown in Figure 1 showing the spacing block after its compression, and

Figure 3 is a view similar to that shown in Figure 2, but showing a spacing block of different shape.

Before describing the representation shown in the drawing, it may be mentioned that any of the usual well-known thermosetting materials can be used in the practice of the invention, including but not limited to polyester resins and epoxy resins. The epoxy resins are well known in the art, and are typically prepared by reacting a material such as bisphenol-A and an epihalogeno-hydrin. Other typical epoxy resins are the epoxidized polyolefins, epoxidized glycerol type materials, and epoxidized cyclohexene type materials, among others. The polyesters which are useful in connection with this invention are the reaction product of polyhydric alcohols and polybasic acids. Preferably in order to provide a material which may be used without solvent, if desired, the polybasic acid is of the unsaturated type. Such unsaturated polyesters are well known in the art and are set forth, for example, in the USA patent specification No. 2,308,495. Polyesters can, if desired, be modified by using a saturated aliphatic polycarboxylic acid as a part of the acidic ingredient and in other ways well known in the art.

The present resinous compositions contain from about 20 to 40 per cent resin, 10 to 20 per cent milled glass fibers, from about 1/4 to 1 inch in length and from about 40 to 70 per cent of finely divided mineral filler, such as calcium carbonate or other finely divided fillers well known to those skilled in the art. The preferable range of materials includes from about 20 to 25 per cent resin, 10 to 15 per cent glass fibers, and from about 60 to 70 per cent finely divided mineral fillers. The specifically preferred composition includes about 22 per cent resin, 11 per cent milled glass fibres as above, and about 67 per cent finely divided mineral fillers. If less than the specified amount of glass fibers are used, the final composition is characterized by deficient strength. On the other hand, if more than the requisite amount of glass fibrous material is used, the final composition tends to be too springy and will not form a suitably compact block. The mineral filler in the amounts specified serves to impart thixotropic characters to the material and to give it a putty-like or molding clay-like consistency.

In preparing the resinous material in suitable block form, the polyester resin along with the curing agent, such as benzoyl peroxide or tertiary butyl perbenzoate, and any of the usual anhydride, acid or amine-containing curing agents for the epoxy resins, and most preferably a material such as boron trifluoride, monoethylamine, which cures at reasonably low temperature, is extruded through a rectangular die of the proper shape and size for the particular structures which are to be spaced. It has unexpectedly been found that when a material so constituted is squeezed or subjected to pressure in any direction perpendicular to the glass fiber orientation or extrusion, the material readily deforms perpendicular to the direction of the applied pressure with little or no deformation in the direction of the extrusion. Such material as described also is elastic in nature so that if the space between conductor bars into which the blocks are placed and squeezed widens, the block will expand up to from about 3 per cent to 5 per cent of its thickness to adjust for such widening. This makes for a finely spaced structure or winding array at all times. It will at once be seen that such a material is admirably suited for the purpose at hand, that of spacing conductor bars. In order to accomplish this purpose, it is simply required that the shaped block of proper size be inserted between the conductor bars with the fibers parallel to the conductor bars. In many cases the block will remain in place by friction until squeezed or it may be held in place by hand or even tying where convenient. If the block is to be tied in place, it is preferably tied so that the glass fiber cords once again are parallel to the direction of the glass fiber orientation, such cords then cutting more readily into the block and more securely holding it in place. With the block in place between the conductor bars and held therebetween either by pressure fit, by reason of glass fiber or similar cords, or other means, the two free sides of the block parallel to the glass fiber orienta-

tion are subjected to pressure in any suitable manner, for example by means of a pincer-like tool or by mechanical pressure exerted upon jaws placed against said sides. As pointed out, when such pressure is applied, the block, which is of about the consistency of modeling clay or stiff putty, extends against the conductor bars, conforming to the shape thereof, and spacing them in a fixed manner. A particular advantage of the present invention is that the blocks need not be assembled in place until the entire end stator winding of the electrodynamic machine, for example, has been assembled. This is a definite advantage over the former wood block spacer system, in which the blocks first had to be fitted one by one and the bars removed from the slot to facilitate the tying of the blocks in place. If desired, the present blocks may be made so that they not only conform to the sides of the bars but also flow over the rounded ends of the bar to a certain degree, thus even more rigidly fixing themselves in place and eliminating without any question any need for tying in place with cords.

Referring to Fig. 1 of the drawing, there are shown in perspective view conductor bars 1 and 2 of the usual well-known type, defining a space 3 therebetween. In space 3 is a block 4 of the present resinous material, the glass fibers of which are preferably oriented in a vertical direction, as seen in the drawing, so that the conforming pressure may be more conveniently applied, after a machine is assembled, to the free sides 5 and 6. In some cases, of course, where the top and bottom of the block are accessible as shown, the orientation may be in the direction from side 5 to side 6, and the pressure applied to the top and bottom of the block. Shown in Fig. 2 is the block of Fig. 1 after the conforming pressure has been applied thereto. From Fig. 1, it will be noted that the block as shown projects slightly above and below the adjacent conductor bars in a direction transversely of the longitudinal direction of the conductor bars, and hence when the conforming pressure is applied, not only does the material flow laterally against the sides of the respective conductor bars, but also bulges slightly up and over to conform partially with the upper periphery of the bars.

Shown in Fig. 3 is another embodiment of the invention in which the block of resinous material 7 is originally not quite as long in a vertical direction as that shown in Figs. 1 and 2. When a snug fit is achieved without subjecting the block to pressure, there is no need for the use of restraining or tying cord, such as of glass fiber. In some cases, the use of glass fiber or other suitable cord 8 is indicated. With the cord tightly tied in place, it tends to cut somewhat into the block and hold it rigidly in place. After the application of the conforming pressure to such a block of limited vertical length, the finished conforming spacer will have a shape and extent somewhat as that shown in Fig. 3.

When all of the spacer blocks are in place, the entire machine is placed in an oven and cured for a suitable length of time peculiar to the particular resin used and depending upon the heat resistance of the machine as a whole. Generally speaking, using epoxy type resins and BF_3-n-methylaniline or aniline complex type curing agents, temperatures of the order of about 80° C. for 16 to 24 hours are sufficient for curing. Using a polyester material known as Glaskyd 1901 manufactured by Perrysburg Laboratories and containing about 22 per cent resin, 67 per cent finely divided filler and 11 per cent milled glass fibers 1/4 inch to 1/2 inch long, a cure of about 8 hours at 80° C. is sufficient. The curing cycles of other suitable resins is well known. In general, materials which do not require curing temperatures of over about 100° C. are preferred.

There is provided, then, by the present invention means for spacing and restricting the relative movement of conductor bars of electrical machinery. Such means are readily inserted in place and adjusted to fulfil their blocking and spacing function. They are furthermore possessed of an elasticity which takes up any additional space which may develop during the assembly of the various parts which are to be spaced. When cured, the blocking and spacing means provide a rigid means for holding and spacing the conductor bars in a unitary composite structure.

WHAT WE CLAIM IS:—

1. A method of manufacturing electrical devices which have conductor bars spaced apart including the step of inserting glass-fibre filled conformable thermosetting resin blocks into space between adjacent conductor bars so as to maintain their spacing and restrict their mutual movement.

2. A method as claimed in claim 1, wherein the said glass fibres are oriented in a direction parallel to the sides of adjacent conductor bars that face the inserted blocks, and wherein the blocks are compressed at right angles to the fibre orientation by a force applied to the sides of the blocks which are parallel to the glass fibre orientation.

3. A method as claimed in claim 2, wherein blocks are used which extend above and below the adjacent conductor bars in a direction transversely of the longitudinal direction of the conductor bars and the glass fibres of which are oriented parallel to the longitudinal direction of the said bars, and wherein the said blocks are compressed at right angles to the fibre glass orientation by a force applied to the sides of the block that extends above and below the adjacent conductor bars.

4. A method as claimed in any one of the preceding claims, wherein the said thermosetting resin blocks contain not more than 20% by weight glass fibres.

5. A method as claimed in any one of the preceding claims, wherein the said thermosetting resin blocks comprise 40% to 70% of finely divided mineral filler and from 10% to 20% of milled glass fibres.

6. A method as claimed in any one of the preceding claims 1 to 4, wherein the said thermosetting resin blocks comprise 60% to 70% of finely divided mineral filler and 10% to 15% of milled glass fibres.

7. A method as claimed in any one of the preceding claims 1 to 4 wherein the said thermosetting resin blocks comprise 67% finely divided mineral filler and 11% milled glass fibres.

8. A method as claimed in any one of the preceding claims wherein said thermosetting resin blocks are initially positioned between said conductor bars and subsequently tied in place with cords.

9. An electrical device when manufactured in accordance with the method claimed in any one of the preceding claims.

10. An electrical device having conductor bars spaced apart and restricted in their relative movement by glass fibre filled resin blocks substantially as described with reference to and as illustrated in Figures 1 and 2 or Figure 3 of the accompanying drawing.

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1 SHEET *This drawing is a reproduction of the Original on a reduced scale*

Fig.1.

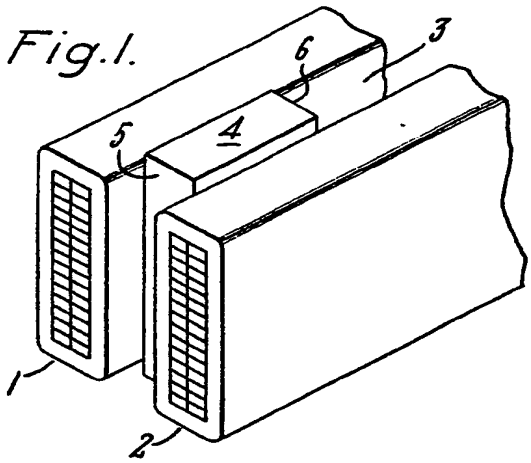

Fig.2.

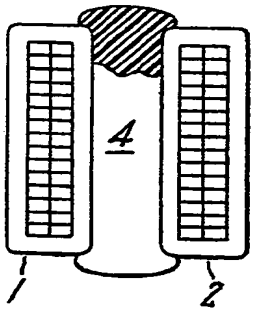

Fig.3.